STUDIES ON THE ALGAL FLORAS INHABITING DIFFERENT WATER SOURCES IN EGYPT
2. LAKES AND SPRINGS

BY
Wafaa S.Abou El-Kheir Ph.D. and Laila Mekkey M.Sc.
University College for Girls, Ain Shams University Egypt.

INTRODUCTION

In Egypt there are ten main lakes varying in their kind of water. Five of these lakes namely: Bardawiel, Manzala, Burullus, Temsah, and the Bitter lakes have marine waters. Whereas the waters of lakes Edku, Mariut and Abbasa are of the brackish type. The only fresh water lake at present is lake Nasser, for lake Qarun is now saline (Abou El-Kheir, 1986). Egyptian springs occur in the oases and deserts. They are also classified according to water kind into fresh, brackish, and saline springs.

No serious efforts have been done to investigate the algal communities inhabiting these water bodies especially springs (Oyoon) which are, up till now, largely neglected. Lake Qarun received more attention than lakes Mariut and Edku where as other lakes received almost no attention.

Works dealing with the algal flora of springs are: Hume (1906) who enumerated 41 diatom species, 27 green and 3 blue-green ones collected from Oyoon Mousa and some Wadis in Sinai peninsula. He stated that Mastogloia smithii and Epithemia gibba (diatoms) are common, and stated also that green algae, particularly the desmids are predominant, whilst the blue-greens are poorly represented. El-Nayal (1935) enumerated 19 species of algae (diatoms and blue-greens) collected from Ein El-Mahareek, Ein Mex Behari and Ein Sirgan in Kharga Oasis. In 1978 Shaaban and El-Habibi studied the algal flora of certain wells in Kharga Oasis. Shaaban (1985) identified 69 species belonging to 35 genera of algae collected from Siwa Oasis (Oyoon and Lakes). He stated that the most common and widely distributed variety is Gomphosphaeria aponina v. aponina. Kobbia (1981) recorded 25 algal species from salt marshes in Ghrabniate in the north-western costal region of Egypt. He found that the blue-greens are the best represented group quantitatively and qualitatively, and the highest phytoplankton biomass was restricted to Oscillatoria limosa, Lyngbya agardhii, Plectonema roseolum, Ulothrix zonata, Achnanthes hungarica and Chromulina ovalis.

In (1986) Abou El-Kheir and Ismail stated that the lack of planktonic and benthic algal flora in Silene spring in El-Fayum is due to the fact that the source of water is the ground deep water and the fact that the rate of flow of water is so fast. These two reasons make the chance for algal community development so little.

The first work on the algal flora of Egyptian lakes was that done by Zanhlbruckner (1904) on lake Mariut and Mallaha at Alexandria. He identified 3 blue-greens including one new species and a new variety. West (1909) identified 66 algal species from Birket Qarun. He stated that greens are poorly represented whereas blue-greens and diatoms are very prominant. In 1935 El-Nayal identified 135 species of algae collected from various localities in Egypt, principally Abbassia, Giza, lake Qarun, lake Temsah, and lake Manzala. Ghazzawi (1939) studied

the phytoplankton of the Suze-Canal and found an increase in the abundance of planktonic diatoms. Abdin (1948 and 1954) studied the algal flora of the Aswan reservoir. In 1958 Aleem recorded 128 fossil diatom species from the old lake Morries (lake Qarun at present) in El-Fayum. He found that the most common species are mainly fresh-water type. Salah (1960) outlined that there are species in lake Mariut and lake Edku (at Alexandria) which can live in either salt or brackish waters, and some are common to both types of water. Nasr et al. (1961) pointed that the kind and distribution of algae is greatly affected by the change of salinity of water in lake Edko. Kaleafah (1964) found Enteromorpha in nearly all parts of lake Mariut whether fresh or brackish, rich or poor in nutrients. In 1970a Nosseir and Abou El-Kheir studied the effect of dissolved nutrients on the algal flora of lake Qarun. They found that the species which are numerous and tolerant are of the marine type. In (1970b) the same authors identified 66 algal species belonging to 31 genera in lake Nasser, and stated that the species which are numerous are of fresh water type. Ehrlich (1975) worked on the diatoms from the surface sediments of Bardawil lake. El-Saadawi et al. (1976) worked on lake Qarun and identified 16 species of diatoms as new records to this lake. Shaaban et al. (1983) in their work on the Mediterranean coast of Egypt (Port-Said, Ras El-Barr, Abu-Qir and Sidi Gaber) found that the algal flora consist of 30 species belonging to macro-greens, reds and browns, but the bulk was nearly of the chlorophyta. Abou El-Kheir and Ismail (1986) studied the extant algal flora of lake Qarun. They also stated that the high salinity affected the algal flora: being rare.

The present study is concerned with the algal flora of lakes and springs in different regions in Egypt. Also with the investigation of the relationship between the algal distribution and the environmental factors. It is also an attempt to find out the difference between the algal floras of lakes and springs which have a somewhat similar salt content.

MATERIAL AND METHODS

Thirteen samples were collected from waters of lakes and springs (Oyoon). The lakes are: lake Qarun in El-Fayum, lake Temsah at El-Ismailia and lake Abbasa in El-Sharkia while the springs are: Ain Helwan in Helwan suburb and Ain El-Sira in Cairo (see Fig. 1). Further details concerning the kind of water and the number of samples taken from each water source are listed below:

Regions	Date of collection	Source of water	Kind of water	No. of samples
Helwan	9/3/1979	Salt spring (Ain Helwan)	Brackish	2
Cairo	9/3/1979	Satl spring (Ain El-Sira)	Brackish	2
El-Ismailia	30/3/1979	Lake Temsah	Marine	3
El-Sharkia	8/2/1980	Lake Abbasa	Brackish	2
El-Fayum	2/7/1980	Lake Qarun	Salt lake (Marine)	4

Brackish water samples contain from 150-250 mg/L. chlorides. Marine water samples contain over 250 mg/L. chlorides. The temperature of the water of all samples was recorded, and pH and chemical analysis of all samples were determined. Intensive microscopic examination of all samples have been done to investigate the algal taxa present.

RESULTS

Microscopic examination of the samples showed that they all contain Bacillariophyta. Chlorophyta was met with in 9 samples, Cyanophyta in 4, Xanthophyta, Euglenophyta and Phaeophyta in one sample each, but Rhodophyta in 2 samples. The 13 samples contain 151 algal taxa belonging to 48 genera representing 7 algal groups, (see table 1). This table shows also that Bacillariophyta is best represented in the lakes, while Chlorophyta and Cyanophyta are best represented in the springs. Xanthophyta, Euglenophyta and Phaeophyta were found only in the brackish lake Abbasa, while Rhodophyta was found in the saline lake Qarun. From tables 2 and 3 it is clear that Chlorophyta (except Cladophora sp.) and Cyanophyta are absent from Ain El-Sira and lake Qarun where the salinity is much higher than that in the other samples. In Ain Helwan Terpsinöe americana (diatoms) represents a new record to Egypt, and it was found only in the two samples collected from this spring. Ectocarpus was found predominant in sample No. 13 from lake Temsah where the nutrients (except chlorides) were relatively low, and it is a new record to this lake. In the samples taken from lake Qarun Rhodochorton purpureum (Rhodophyta) was found dominant, and it is a new record to Egypt. Polysiphonia sp. was found predominant and Goniotrichum elegans was found dominant and the two taxa are new to lake Qarun (both are Rhodophyta). In lake Abbasa Tribonema sp. (Xanthophyta) and Spirogyra sp. (Chlorophyta) were predominat. Cladophora sp. was found predominant and dominant in most of the samples taken from springs and lakes (respectively).

Samples no. 3 and 4 taken from the mineral spring "Ain El-Sira" is the poorest of all samples in the algal flora and Bacillariophyta is the only group found.Although it has the highst values of chlorides (highly saline) yet the fresh water form Nitzschia palea genuina f. minor was dominant whereas brackish - marine form Amphora Coffaeiformis boreales was predominant.

DISCUSSION

The present study includes 13 samples, six of them are brackish (chlorides content above 150 mg/L). The word brackish strictly means between fresh and salty water (see Kolbe,1927 and Lund ,1965), however, most of the brackish samples in this study have chlorides content like that of marine water i.e. above 250 mg/L. But since these samples were collected from isolated inland sources of water and lie at considerable distances from seas, they were therfore considered brackish and not marine. They also maintain algal elements that are mainly brackish and fresh water forms.

Although lake Qarun lies at considerable distances from seas and has, at present, highly saline waters yet it is considered marine and not brackish because it maintains, at present, a mainly marine algal flora. The presence of this type of flora in this inland lake is due to the transfer

of Mediterranean sea-waters from near Alexandria to the lake for reasons given by Abou El-Kheir (1986).

The results given in tables 1 and 2 show that Bacillariophyta is best represented in marine waters and is poorly represented in highly saline samples (samples no. 3 and 4), despite the fact that these samples contain high values of all nutrients (except PO_4). In these two highly saline samples no Chlorophyceae and Cyanophyceae were found. This is in agreement with Abou El-Kheir and Ismail (1986) who stated that high salinity in lake Qarun was accompanied by reduced algal flora. Chlorophyta is again like Cyanophyta; being well represented in brackish waters (see tables 2 and 3). These results are to some extent in agreement with results obtained by Angot and Robert (1966) who stated that high salinity is favourable for diatoms and unfavourable for Cyanophyta and Chlorophyta. But are not in agreement with results obtained by Iltis (1973) who stated that blue-greens tolerate variation of salinity, or with those obtained by Kobbia (1981) who stated that the dominance of blue-greens in salt marshes is most probably due to the high tolerance of salinity compared to other species. And is not in agreement with Seenayya (1972) who stated that blue-greens have high ability to develop in extremely wide range of ecological conditions. The ability of numerous species of blue-green algae to flourish under high salinity and temperature variations had been shown by Levandowsky (1972) and Shubert (1976), however this does not apply to blue-green species recorded in the present work. Fogg et al. (1973) showed that the halophilic blue-green algal speies which can grow at high salt concentrations are probably capable to do so due to their prokryotic organization and the absence of large sap vacules. This may explain the presence of Schizothrix calcicola minuta as a common species in sample no.11 from lake Temsah.

Round (1973) and Abou El-Kheir and Mekkey (1986b) stated that sodium is important for the development of Cyanophyta. This not in agreement with the present results, since, samples no. 5 and 8 from lake Qarun and sample no. 3 from Ain El-Sira are the richest samples in sodium content (table 2), however, Cyanophyta is absent from these samples. This may be due to high chlorides content in these samples.

Comparing the results obtained here with those of Abou El-Kheir and Mekkey (1986a) from their work on the River Nile and its derivatives which have fresh waters, it may be said that algae are generally best represented in fresh then brackish and finally marine waters. The details of this comparison show that Bacillariophyta occurs in all sources of water, but is best represented in fresh water sources followed by marine ones. While Cyanophyta and Chlorphyta are best represented in fresh water sources, poorly represented in brackish and nearly absent in marine ones.

SUMMARY

151 species of algal taxa are recorded from the three studied lakes and the two springs. Temperature, pH and chemical analysis for all samples were determined. Bacillariophyta was found in all samples, Cyanophyta and Chlorophyta in the brackish ones and absent from the high salty ones. Xanthophyta, Euglenophyta, Phaeophyta and Rhodophyta are met with but are quite few in number and not in all samples. Algal flora is generally best represented in fresh waters followed by brackish then marine. Bacil-

lariophyta is more tolerant to salinity than other algal groups. Salinity is a determining factor for the growth of algae especially Cyanophyta and Chlorophyta. Two taxa are recorded new to the algal flora of Egypt, namely: Terpsinöe americana (Bacillariophyta) and Rhodochorton purpureum (Rhodophyta).

REFERENCES

Abdin, G., 1948. Condition of growth and periodicity of the algal flora of Aswan Reservoir. Bull. of Fac. Sc. Cairo Univ., 27:157-176.

———— , 1954. Algal lithophytes of Aswan Reservoir Area. Bull. Inst. de Egypt 35:39-102.

Abou El-Kheir, W.S., 1986. Change in the diatom flora of lake Qarun with time. Ain Shams Sci. Bull. 28(accepted).

———— and Ismail, G.H., 1986. Notes on the aquatic habitats of macrohydrophytes and associated algae in various regions in Egypt. 1-El-Fayum region. Phytologia 60:469-482.

———— and Mekkey, L.E., 1986a. Studies on the algal flora of different water sources from different regions in Egypt. 1-River Nile and its derivatives (submitted for publication).

———— and Mekkey, L.E., 1986b. Sudies on the algal flora of different water sources from different regions in Egypt. 3. Drains and Swamps (in preparation).

Aleem, A.A., 1958. A taxonomic and paleoecological investigation of the diatom-flora of the extinct Fayum Lake (Upper Egypt) Bull. Fac. of Sc. Alex. Univ., Vol. 2:217-245.

Angot, M. and Robert, G., 1966. Hydrology and phytoplankton in surface water at Nosy-Be in April 1965. Cahorstan Ser. Oceanogr. 4(1), 95-136.

Ehrlich, A., 1975. The diatoms from the surface sediments of the Bardawil lagoon (Northern Sinai) paleoecological significance. Nova Hedwigia, Beifft. 53:253.

El-Nayal, A.A., 1935. Egyptian fresh water algae. Bull. Fac. Sc. No. 4:1-106.

El-Saadawi, W.E., Badawi, A.A., Shaaban, A.A. and El-Awamri, A. 1978. Pleistocene diatoms from El-Fayum. Proc. Egypt. Acad. Sci., 31:257-263.

Fogg, G.E., Stewart, W.D.P., Fay, P. and Walsby, A.E., 1973. The blue-green algae . Press, London and New York.

Gazzawi, F.M., 1939. A study of the Suez Canal plankton, the phytoplankton. Hydrob. and Fish-Directorate, Notes and Memoires No. 24, Egypt.

Hume, W.E., 1906. The topography and geology of the peninsula of Sinai (South eastern portion), Cairo, 1906, 231-233.

Iltis, A., 1973. Algae of the waters of the kanon (Chad.) 2 CAHO. Restomser Hydrobiol. 7(1):25-54.

Kaleafah, A.F., 1964. Ecology of algae in lake Mariut. M.Sc. Thesis. Fac. Sc. Alex. Univ.

Kobbia, L.A., 1981. Seasonal variations of phytoplankton in the salt marshes of Egypt. J. Bot. Vol. 24, No. 3: 153-233.

Kolbe, R.W., 1927. Zur Okologie Morphologie und Systematik der brackwasser-diatomeen die Kiesselalgen des sperberger salzgebiets. Pflanzen forschung 7:1-146.

Levandowsky, M., 1972. An ordination of phytoplankton in ponds of varying salinity and temperature. J. Ecol. 53:398.

Lund, J.W.G., 1965. The ecology of the fresh water phytoplankton. Biol. Rev. 40:231-293.

Nasr, A.H., Hashim, M.A. and Aleem, A.A., 1961. The flora of lake Edku, with particular reference to benthic diatoms. Bull. Fac. Sc. Alex. Univ., U.A.R. 5:219-234.

Nosseir, M.A. and Abou El-Kheir, W.S., 1970a. Effect of dissolved nutrients on the distribution of algal flora in selected lakes of U.A.R., 1-Lake Qarun. Ann. Rev. Univ. Coll. Girls, Ain Shams Univ. No. 6:15-24.

———————————— 1970 b. Effect of dissolved nutrients on the distribution of algal flora in selected lakes of U.A.R., II-Lake Nasser. Ann. Rev. Univ. Coll. Girls Ain Shams Univ. No. 6:33-47.

Round, F.E., 1973. The biology of algae. Edward Arnold. London.

Salah, M.M., 1960. The phytoplankton of lake Maruit and lake Edku with a general contribution to the Halobian System. Hydrob. Dep., Alex. Inst. Hydrob. Notes and Mem. No. 57:1-15.

Seenayya, G., 1972. Ecological studies in the plankton of certain fresh water ponds of Hyderabad. India II- Phytoplankton 2.

Shaaban, A.S., 1985. The algal flora of Egyptian Oases II-On the algae of Siwa oasis. Proc. Egypt. Bot. Soc. 4, 1985, 1-10.

——— and El-Habibi, A. 1978. The algal flora of Egyptian Oases. 1- The algal flora of Kharga oasis. Bull. Inst. Dest. 28, 1.

————, El-Habibi, A. and El-Naggar, M.E., 1983. Algal vegetation of the Mediterranean coast of Egypt. J. Bot., Vol. 24, No. 3: 179-190.

Shubert, L.E. 1976. Investigation of the algal growth potential of Devils lake. North Dakota USDI, Bureau of Reclamation Report, 150 pp.

West, 1909. The algae of the Birket Qarun, Egypt. Journ. of Bot. Vol. 47.

Zahlbruckner, A. 1904. Kryptogamae exsiccate centuria X-XI Ann. der K.K Naturhistorischen Hofmuseums, XIX Band, Wien 1904 pp. 402-3.

Table (1): Number of taxa of various divisions of algae recorded in water samples taken from the studied lakes and springs: A.H. = Ain Helwan, A.S. = Ain El-Sira, Q.F. = Qarun, El-Fayum, A.Sh. = Abbasa, El-Sharkia, T.IS. = Temsah El-Ismailia, B = Brackish, M = Marine.

Algal Divissions	Regions sample No. water type												
	A.H.		A.S.		Q.F.				A.Sh.		T.IS.		
	B		B		M				B		M		
	1	2	3	4	5	6	7	8	9	10	11	12	13
Bacillariophyta	19	12	2	5	20	28	33	15	8	18	26	18	36
Chlorophyta	4	2	-	-	-	1	1	1	-	2	2	1	1
Cyanophyta	5	3	-	-	-	-	-	-	-	2	3	-	-
Euglenophyta	-	-	-	-	-	-	-	-	-	1	-	-	-
Xanthophyta	-	-	-	-	-	-	-	-	3	-	-	-	-
Paeophyta	-	-	-	-	-	-	-	-	-	-	-	-	1
Rhodophyta	-	-	-	-	3	3	3	3	-	-	-	-	-

Table (2): Values of pH, temperature, and other nutrients in the studied samples from lakes and springs A.H = Ain Helwan, A.S. = Ain El-Sira, A.F. = Qarun El-Fayum A.Sh. = Abbasa, El-Sharkia, T.IS. = Temsah, El-Ismailia, Nut. = Nutrients (p.p.m.).

Sample No.	Springs				Lakes								
	A.H.		A.S.		Q.F.				A.Sh.		I.IS.		
Nut. pH Temp.	1	2	3	4	5	6	7	8	9	10	11	12	13
pH	8	8	7.7	7.7	6.8	7	6.8	7.2	6.5	6.5	6.5	6.5	6.5
Temp. °C	26	26	17	18	35	38	34	38	17.5	17	28	25	24
NO_3	5.3	2.2	55.6	0.5	0.7	1.25	-	-	8.7	4.8	8.2	8	21.5
PO_4	0.3	-	3.1	0.8	1.7	4.9	26	6.1	6.1	0.9	1.7	1.4	2.8
Cl	1663.8	2000.1	50728.2	4370	12390	12460.8	11221.8	2318.7	1663.8	212.4	13983	814.2	10867.8
Na	241.5	575	10301.4	2070	2127.5	1150	684.2	2300	287.5	1437.5	218.5	586.5	533.6
Ca	2.4	2.4	12.7	8.1	5.8	4.5	4.3	7.7	0.1	0.1	3.3	1.0	3.4
Mg	1.8	1.8	34	7.3	4	10.2	10.8	6.9	1.7	0.2	11.7	0.6	6
K	40.8	39	507	101.4	179.4	46.8	54.6	46.8	7.8	15.6	62.4	39	54.6
CO_3	-	-	-	-	-	-	-	-	-	-	280	-	-
HCO_3	132.2	30.5	61	71.2	167.8	152.5	183	137.3	183	1901.1	30.5	198.3	101.7

Table (3): Algal taxa distribution in the samples taken from lakes and springs: A.H. = Ain Helwan, A.S. = Ain El-Sira, Q.F. = Qarun El-Fayum, A.Sh. = Abbasa El-Sharkia, T.IS. = Temsah El-Ismailia C = Common, d = dominant, p. = predominant.

Algal taxa	Springs				Lakes								
	A.H		A.S		Q.F.			A.Sh		T.IS.			
	1	2	3	4	5	6	7	8	9	10	11	12	13
Bacillariophyta: Centrales:													
1. Biddulphia polymorpha(Grun.)Wolle	+	+			+								
2. Cyclotella bodanica lemanensis O.M.						+	+						
3. C. comensis Grun.							+			+			
4. C. gothica A.Cl.							+						
5. C. meneghiniana genuina A.Cl.										+	+		+
6. C. meneghiniana plana Fricke												+	
7. C. ocellata Pant.	+								+		+	+	
8. Melosira fennoscandica						+						+	+
9. M. granulata E.						+	+						
10. M. granulata angustissima O.M.	+									+	+		+
11. M. islandica typica A.Cl.										+			
12. M. Jurgensii bothnica Grun.						+	+	+					
13. M. varians Ag.									+	+			
14. M. dubia Kz.											+		+
15. Paralia genuina A.Cl.											+		
16. P. sulcata crenulata Grun.													+
17. Terpsinöe americana (Bail) R.	+	+											
18. Triceratum antediluvianus (E.) Grun.					+		+	+					
19. T. reticulum f. trigora						+	+						
20. Stephanodiscus astraea Niagarae					+	+	+						
Pennales:													
21. Achananthes brevipes angustata (G.)Cl.	+	+			+	+	+	+					
22. A. brevipes intermedia Kz.	+	+									+		+
23. A. brevipes elliptica Cl.											+		
24. A. brevipes typica Cl.											+		+
25. A. coarctata constricta krass.											+		+
26. A. delicatula genuina A.Cl.							+	+					
27. A. delicatula subcapitata(Ost.)A.Cl.						+	+	+					
28. A. Schmidtiana Krenn.								+					
29. A.septata linearis A.Cl.											+		
30. Amphiprora alata genuina A.Cl.								+					
31. A. paludosa punctulata Grun.									+				+
32. Amphora acutiucscula Kz.													+
33. A. coffaeiformis borealis				+									
34. A. coffaeiformis salina(W.Sm.)A.Cl.			+	+	+	+	+						+
35. A. eunotic Cl.													+
36. A. libyca typica A.Cl.													+
36. A. libyca typica A.Cl.													+
37. A. terroris E.											+		
38. A. turgida A.Cl.	+												
39. Bacillaria paradoxa Gmel.									+				

Table (3): (Cont.)

Algal taxa	Springs				Lakes								
	A.H		A.S		Q.F.				A.Sh		T.IS.		
	1	2	3	4	5	6	7	8	9	10	11	12	13
40. Cocconeis disculus minor Font.							+	+					
41. C. placentula euglypta (E.) Grun.						+	+	+	+				
42. C. placentula genuina May	+												
43. C. placentula intermedia (Her&Pet)Hust.											+		+
44. C. placentula lineata A.Cl.												+	
45. C. scutellum Ehr.											+		+
46. Denticula tenuis frigida (Kz.)Grun.												+	
47. Diatoma elongatum subsalsum A.Cl.													+
48. Dimeregrama fulva (Greg.)Ralfs					+	+	+						
49. D. minor nana					+	+	+						
50. Diploneis elliptica genuina f. minor	+	+											
51. Fragilaria capucina aretica A.Cl.	+	+											
52. F. vaucheriae genuina (V.H.)A.Cl.	+												
53. F. vaucheriae gracilior	+												
54. F. vireacene lanceola					+								
55. Gomphonema gracile intricatiforme May										+	+		
56. G. lanceolatum insigne genuinum												+	
57. G. olivaceum tenellum Kz.												+	
58. G. montanum genuina May										+			
59. G. parvulum exilissimum Grun.										+			
60. Grammatophora marina (Lyngb.)Kz.					+	+	+	+					
61. G. marina adrialica						+	+						
62. G. oceanica macilenta					+								
63. Gyrosigma acuminatum (W.Sm.)A.Cl.	+	+											
64. G. spencerii smithii (Grun.)A.Cl.											+		+
65. Licmorphora abbreviata Ag.					+	+	+						
66. L. ehrenbergii genuina A.Cl.						+							
67. L. gracilis anglica (Kz.) Per.													+
68. L. tincta nubecula (Kz.) Grun.					+								
69. Mastogloia smithii genuina f. minor						+						+	
70. Navicula ambigua diminuta										+			
71. N. ammophila genuina A.Cl.				+									+
72. N. avenaceae Breb.										+	+	+	
73. N. cryptocephala perminuta Grun.								+					
74. N. Cryptocephala Subsalina Hust.	+	+				+	+	+					+
75. N. jaagi Meist.							+						
76. N. lanceolata genuina A.Cl.							+						
77. N. modica													+
78. N. mutata typica A.Cl.													+
79. N. pupula genuina Grun.													+
80. N. radiosa cuneata								+					
81. N. viridula capitata Mag.		+				+						+	+
82. Nitzschia amphibia acutiuscula				+							+		
83. N. apiculata (Greg.) Grun.	+	+			+	+	+	+		+	+		+
84. N. dissipreta genuina A.Cl.											+		
85. N. granulata Grun.	+												
86. Hantzschia genuina A.Cl.											+		

Table (3): (Cont.)

Algal taxa	Springs				Lakes								
	A.H		A.S		Q.F.			A.Sh		T.IS.			
	1	2	3	4	5	6	7	8	9	10	11	12	13
87. N. intermedia Hant.									+		+		
88. N. obtusa scalpelliformis Grun.							+				+		
89. N. obtusa vulgaris Grun.											+		
90. N. palea genuina f. minuta				+									
91. N. paradoxa genuina Grun.												+	
92. N. punctata aurta Grun.						+	+		+				
93. N. sigma clausii (Htz.) Grun.	+	+											
94. N. sigma clausii f. major	+												
95. N. sigma interceedens Grun.							+						
96. N. sigma major												+	
97. N. smithii genuina Grun.												+	
98. N. socialis genuina Grun.							+	+					
99. N. thermalis genuina May.												+	
100. N. thermalis intermedia Grun.										+	+		
101. N. tryplionella crassa (Pant.) A.Cl.												+	
102. N. vermicularis genuina A.Cl.										+	+	+	
103. N. vermicularis lamprocampa									+				
104. Pinnularia spitzbergensis f. continua											+		
105. Pleurosigma formosum W.Sm.													+
106. Rhoicosphenia curvata marina(W.Sm.) Grun.												+	
107. Ropalodia gibba genuina Grun.										+			
108. R. gibba ventricosa (Kz.) Grun.										+			+
109. R. gibberula constricta W.Sm.					+	+		+		+			
110. R. gibberula producta (Grun.)A.Cl.												+	
111. R. giberula vanheurchii										+			
112. R. musculus										+			
113. Sceptroneis australis borealis f.angustata					+	+	+						
114. Steriatella unipunctata (Lyn.)A.Cl.													+
115. Surierella fossilis A.Cl.													+
116. S. laevis A.Cl.	+	+											
117. S. turgida A.S.										+			
118. Synedra acus genuina May													+
119. S. affinis													+
120. S. berolinensis Lemm.													+
121. S. crystalline smithii Grun.							+	+					
122. S. fulgen (Grev.) S.Sm.					+								
123. S. tabulata fasciculata(Kz.)Hust.									+				
124. S. tabulata lamprocampa Hantz.								+					
125. S. tenera genuina A.Cl.						+	+	+				+	
126. S. ulna danica (Kz.) Grun.						+	+	+	+				+
127. S. ulna pxythynchus (Kz.) Hust.													+
Chlorophyta													
128. Ankistrodesmus spirales fosciculatus													+
129. Chlorococcum humicola	+									+	+	+	
130. Cladophora sp.	c	p			d	d	d				p		

Table (3): (Cont.)

Algal taxa	Springs				Lakes								
	A.H		A.S		Q.F.				A.Sh		T.IS.		
	1	2	3	4	5	6	7	8	9	10	11	12	13
131. Enteromorpha hexuosa pausirzschria	p	+											
132. Mougeotia sp.	c												
133. Spriogy a sp.										p			
Cyanophyta:													
134. Anabena constricta										+			
135. Heterothrix mucicola										+			
136. Lyngbya majuscula	c	c											
137. L. martensiana											c		
138. Oscillatoria amphibia	+												
139. O. limosa	d												
140. O. okeni											+		
141. O. ornata	+	+											
142. O. tenuis											+		
143. Schizothrix calcicola minuta	d	d									c		
Euglenophyta:													
144. Euglena oxyuris									+				
145. Phacus anomala									+				
146. P. curvicauda									+				
Santhophyta:													
147. Tribonema sp.										d			
Phaeophyta													
148. Ectocarpus sp.													p
Rhodophyta:													
149. Goniotricium elegans						d	d	d	d				
150. Polysiphonia sp.						p	p	p	p				
151. Rhodochorton purpureum						d	d	d	d				